A programmable electronic timer based on linear or non-linear programmable functions

A programmable electronic timer based on linear or non-linear programmable functions is a machine that can be programmed to time certain activities based on specific functions. Thus, as opposed to regular timers, which produce an event after some time has passed, this device will produce events based on a functional transformation of time. An application described therein is a programmable timer to be used by students taking the SAT test.

U.S. Patent Application of:

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TITLE OF INVENTION

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CROSS-REFERENCE TO RELATED APPLICATIONS

Not Applicable

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

Not Applicable

REFERENCE TO A MICROFICHE APPENDIX

Not Applicable

BACKGROUND OF THE INVENTION

This invention relates generally to the field of timing devices, and more particularly to a programmable timer for measuring time based on linear or non-linear programmable functions.

This device can be programmed to time certain activities based on specific functions. Thus, as opposed to regular timers, which produce an event after a certain time interval has passed, this device will produce events based on a functional transformation of time. An application described therein is a programmable timer to be used by students taking the SAT test.

NOTE: In this document, the word "section" refers to:

1. A section of time that can be programmed with a function using this invention.
2. A section of an exam, as part of the exam. A section of the exam can be covered by several programmed sections of the device. The total time allocated for these programmed sections of the device will be equal to the time reserved for that section of the exam.

Currently, during exams, students use a regular watch to time their efforts. Even when the questions are grouped by difficulty and the effort is predictable, it is still very difficult to figure out if there is enough time to finish or not. Students use calculators and watches, but none of them help to pace their efforts.
Calculators have a similar setup in terms of hardware, but do not have the capability to program functions with true current time as the independent variable.

Watches display time, but do not allow any alteration or programming. Stopwatches allow measuring time intervals, but do not allow any alteration or programming.

None of these devices adapt to the effort required for the task, allowing longer time for higher expected effort and shorter time for easier tasks.

BRIEF SUMMARY OF THE INVENTION

The primary object of the invention is to provide a device that helps humans match their effort with tasks that vary in intensity and difficulty.

Another object of the invention is to provide a device that helps humans maximize performance for tasks that vary in intensity and difficulty, by repeating the tasks, measuring the effort and tuning the pacing of the effort.

Another object of the invention is to provide a device that helps a machine match output with an input that is non-linear and predictable in time.

A further object of the invention is to provide a device that allows students taking an exam to pace their efforts and maximize score.

Yet another object of the invention is to allow students to know if they are ahead or behind during exams and apply a better strategy for skipping questions and guessing answers.

Still yet another object of the invention is to allow students to take advantage of prior knowledge about the difficulty of questions and their ordering based on difficulty and pace the exam accordingly.

Another object of the invention is to allow students to tune their performance based on previous tests, reserving adequate amount of time for questions and avoiding panic.

Another object of the invention is to allow runners for long races, such as a marathon, to pace their efforts better, conserve energy, sprint at a moment that is convenient for them.

A further object of the invention is to allow recipients of medicine to tune delivery based on personal effort. .

Yet another object of the invention is to allow heating to match nonlinear, predictable change in the temperature of the environment.

Other objects and advantages of the present invention will become apparent from the following descriptions, taken in connection with the accompanying drawings, wherein, by way of illustration and example, an embodiment of the present invention is disclosed.

A programmable machine for measuring time based on linear or non-linear programmable functions comprising: a display, a button keyboard pad, an electronic memory that contains the function definition and function parameters for each section of time, a Logical Computation Unit that converts equally spaced time impulses from the clock to linearly or non-linearly spaced time impulses, based on functions stored in memory, an electronic clock that generates equally spaced impulses, that are fed to the logical unit for transformation, and a start / stop button that switches modes from input mode to running mode and back.

A programmable machine for measuring time for exam events such as the SAT or PSAT with a purpose of improving student performance, comprising Display, Button pad keyboard comprising mode entry selection buttons, section selection buttons, option selection buttons, numeric buttons, Electronic memory that stores running parameters for each section of time, Logical Computation Unit that converts equally spaced time impulses from the clock to question counter increases based on a programmable function, Clock that generates equally spaced impulses, and Start / Stop button that switches mode from input mode to running mode.

The drawings constitute a part of this specification and include exemplary embodiments to the invention, which may be embodied in various forms. It is to be understood that in some instances various aspects of the invention may be shown exaggerated or enlarged to facilitate an understanding of the invention.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

FIG. 10 is a plan view of the invention, with a physical appearance similar to a calculator, in setting mode.

FIG. 15 is a plan view of the invention, with a physical appearance similar to a calculator, in running mode.

FIG. 20 is a plan view of the invention, with a physical appearance similar to a wristwatch, in setting mode.

FIG. 25 is a plan view of the invention, with a physical appearance similar to a wristwatch, in running mode.

FIG. 30 is a schematic diagram illustrating the data flow between the elements of the invention.

FIG. 40 is a flow chart of the operations that are performed by the logical unit.

DETAILED DESCRIPTION OF THE PREFERED EMBODIMENTS OF THE INVENTION

Detailed descriptions of the preferred embodiment are provided herein. It is to be understood, however, that the present invention may be embodied in various forms. Therefore, specific details disclosed herein are not to be interpreted as limiting, but rather as a basis for the claims and as a representative basis for teaching one skilled in

the art to employ the present invention in virtually any appropriately detailed system, structure or manner.

BACKGROUND OF THE INVENTION

The current invention relates to specialized electronic timers, specifically to programmable timers.

Programmable timers in prior art measure straight time intervals and produce a timer event, such as a sound or a state change when the programmed time expires.

The timers introduced by this invention separate a certain large interval of time into several sections. For each section, timer events are produced based on a programmed function. This function can be dynamically programmed (programmed by the user each time the timer is used) or can be pre-programmed. The function has to be a positive monotonic function. The independent variable of the function is time, generated by an electronic clock. The dependent variable is represented by time events, generated by a logic unit that computes the value of the function and generates a timer event each time the integer value of the function increases.

The following table examples illustrate this concept.

Table 50 presents what timer events are created when the programmed function is the identity function y=x. In this case, the timer will behave as a normal timer.

Time (in seconds)	Function y = x (regular time)	Timer Events
0.1	0.1	
0.2	0.2	
0.3	0.3	
0.4	0.4	
0.5	0.5	
0.6	0.6	

0.7	0.7	
0.8	0.8	
0.9	0.9	
1	1	tick
1.1	1.1	
1.2	1.2	
1.3	1.3	
1.4	1.4	
1.5	1.5	
1.6	1.6	
1.7	1.7	
1.8	1.8	
1.9	1.9	
2	2	tick
2.1	2.1	
2.2	2.2	
2.3	2.3	
2.4	2.4	
2.5	2.5	
2.6	2.6	
2.7	2.7	
2.8	2.8	
2.9	2.9	
3	3	tick
3.1	3.1	
3.2	3.2	
3.3	3.3	
3.4	3.4	
3.5	3.5	
3.6	3.6	
3.7	3.7	
3.8	3.8	
3.9	3.9	
4	4	tick

Table 50: Regular time. Transformation function y = x (normal time)

Table 60 presents what timer events are created when the programmed function is the linear function y=2x, a function that speeds up time. Timer events in this case are generated every half a second.

Time (in seconds)	Function y = 2*x (speeding up)	Timer Events
0.1	0.2	
0.2	0.4	
0.3	0.6	
0.4	0.8	
0.5	1	tick
0.6	1.2	
0.7	1.4	
0.8	1.6	
0.9	1.8	
1	2	tick
1.1	2.2	
1.2	2.4	
1.3	2.6	
1.4	2.8	
1.5	3	tick
1.6	3.2	
1.7	3.4	
1.8	3.6	
1.9	3.8	
2	4	tick
2.1	4.2	
2.2	4.4	
2.3	4.6	
2.4	4.8	
2.5	5	tick
2.6	5.2	
2.7	5.4	
2.8	5.6	
2.9	5.8	
3	6	tick
3.1	6.2	
3.2	6.4	
3.3	6.6	
3.4	6.8	
3.5	7	tick
3.6	7.2	
3.7	7.4	
3.8	7.6	
3.9	7.8	
4	8	tick

Table 60: Linear Speeding up time. Transformation function y = 2*x (speeding up)

Table 70 presents what timer events are created when the programmed function is the linear function y=0.5x, a function that slows down time. Timer events in this case are generated every two seconds.

Time (in seconds)	Function y = ½*x (slowing down	Timer Events
0.1	0.05	
0.2	0.1	
0.3	0.15	
0.4	0.2	
0.5	0.25	
0.6	0.3	
0.7	0.35	
0.8	0.4	
0.9	0.45	
1	0.5	
1.1	0.55	
1.2	0.6	
1.3	0.65	
1.4	0.7	
1.5	0.75	
1.6	0.8	
1.7	0.85	
1.8	0.9	
1.9	0.95	
2	1	tick
2.1	1.05	
2.2	1.1	
2.3	1.15	
2.4	1.2	
2.5	1.25	
2.6	1.3	
2.7	1.35	
2.8	1.4	
2.9	1.45	
3	1.5	
3.1	1.55	
3.2	1.6	
3.3	1.65	
3.4	1.7	
3.5	1.75	

3.6	1.8	
3.7	1.85	
3.8	1.9	
3.9	1.95	
4	2	tick

Table 70: Slowing down time. Transformation function y = ½ * x

Table 80 presents what timer events are created when the programmed function is the non-linear function y=exp(x). This function will provide more and more timer events as time passes.

Time (in seconds)	Function y = exp(x)	Timer Events
0.1	1.105171	tick
0.2	1.221403	
0.3	1.349859	
0.4	1.491825	
0.5	1.648721	
0.6	1.822119	
0.7	2.013753	tick
0.8	2.225541	
0.9	2.459603	
1	2.718282	
1.1	3.004166	tick
1.2	3.320117	
1.3	3.669297	
1.4	4.0552	tick
1.5	4.481689	
1.6	4.953032	
1.7	5.473947	tick
1.8	6.049647	tick
1.9	6.685894	
2	7.389056	tick
2.1	8.16617	tick
2.2	9.025013	tick
2.3	9.974182	
2.4	11.02318	tick,tick
2.5	12.18249	tick
2.6	13.46374	tick
2.7	14.87973	tick
2.8	16.44465	tick,tick
2.9	18.17415	tick,tick
3	20.08554	tick,tick
3.1	22.19795	tick,tick
3.2	24.53253	tick,tick
3.3	27.11264	tick,tick,tick
3.4	29.9641	tick,tick
3.5	33.11545	tick,tick,tick,tick
3.6	36.59823	tick,tick,tick

3.7	40.4473	tick,tick,tick,tick
3.8	44.70118	tick,tick,tick,tick
3.9	49.40245	tick,tick,tick,tick,tick
4	54.59815	tick,tick,tick,tick,tick

Table 80. Non-linear transformation: y = exp(x)

The presentation of programmed functions in this table is just an example. The independent variable (time) can be measured in any unit, not just seconds and the principle of applying a function to it is the same. The timer generates time events for the first section applying the first function and, when the time expires for the first section, the timer will advance to the second section and apply the second function for the timer events, and so on. Associated with each section is a flag that indicates if the time counter should be reset when the section begins, bringing the independent variable back to 0.

Referring to ***Figure 10***, a portable electronic timer of the type that may employ the features of this invention is shown in pictorial form. Its embodiment is similar to a portable electronic calculator. This particular embodiment of the invention is to be used in timing standardized tests, such as the SAT and the PSAT. These tests have a pre-determined number of sections. For each section, there are several groups of questions. Each group of questions is comprised by easy questions, medium difficulty questions and hard questions, in that order. It is difficult for the student taking these standardized tests to pace the effort, since more time is needed for the hard questions than for the easy ones. Some students, who very rarely are able to answer hard questions, may forego answering all or some of the hard questions and spend time for the easy questions and more time for the medium difficulty questions, in order to maximize their score. This electronic timer will show them what question they are supposed to be answering at any particular time. This information will allow them to

think more about the question, guess, or skip the question depending of their being ahead or behind the question displayed by the timer.

The electronic timer 101 comprises a liquid crystal display 102, a button keyboard pad which comprises a questions set button 104, a time set button 105, a timer reset button 106, a section reset button 107, an SAT presetting button 108, a PSAT presetting button 109, two personal presetting memory buttons 110 and 111, two section setting buttons 112 and 113, numeric keypad with keys 0-9 120, a clear entry button 114 , an alarm setting button 116, a timer mode button 117 a Start/Stop button 118 and an On/Off button 119.

The operation of the device is as follows:

The user will turn the device on from the On/Off button. The display will show:

Section 1		PERS1
Time 0	Reset No	Timer Down
Questions 0	Reset No	Alarm Off

The user will press Time (button 5). The display will blink the Time setting. The user will enter the time, in minutes allocated for this section. Setting the time in minutes is particular to this application. Different applications may use different time measurements. Then the user will press Questions (button 4). The display will blink the Question setting. The user will set the number of questions for that section.

Then the user will decide if the timer will be reset at the beginning of this section by pressing the Time Reset button. This button toggles the Time Reset setting for the section. Then the user will decide if the question counter will be reset at the beginning of this section by pressing the Que. Reset button. This button toggles the Questions Reset

setting for the section. When the timer is in the running mode, at the beginning of a section that indicates Time Reset, the displayed timer will start again from 0. This feature allows the user to time independently test sections, each of which is constituted of several timer sections. Each timer section corresponds to a sub-group of questions of the test section. When the timer is in the running mode, at the begging of a section that indicates Question Reset, the displayed question starts again at 1. This feature allows the user to see to question counting independently for each test section.

Then the user will user the Section ^ button to advance to the next section and set it in a similar manner.

At any time, the user can select the Timer Mode by pressing on the Timer Mode button. If the timer mode is set to UP, the time displayed will go from 0 to the total for all the sections that do not require a timer reset. If the timer mode is set to DOWN, the time displayed is the sum of the specified time for all the sections up to the next section programmed for Time Reset. The time goes down from there and reaches 0 at the end that group of sections. This allows the user to know how much time is left for a certain test section.

Sections that have the Time set to 0 will be skipped, independently of setting of the Questions. Sections that have the Time set to a non-zero value, but the questions set to a 0 value, will consume the time specified, without increasing or modifying the Questions number. They are to be used to program the pauses in the test.

After all the desired sections are programmed, the user can select, using the Section ^ and Section v buttons the section from which to start the timer, then the user

can press the Start/Stop button. This will start the timer and the screen will change to display the question,

This particular embodiment of the solution uses linear time functions. The slope of the linear function is determined by the duration of the section and the programmed number of questions per section. The timer section of the programmed prototype provides an example of how the logical unit may be built.

The following is Visual Basic commented code, detailing the functionality of the logical unit. The logical unit will execute by hardware the same or similar logic functionality as described by this software. This prototype does not support the TimerMode DOWN. All other limitations of the prototype compared with the described electronic timer from ***Figure 10*** are described in the code comments.

```
'Initialization
'setting the counters. Unlike the described device, the prototype
'always starts with section 1 and has only 6 sections.


QuestionCounter = 1
DisplayQuestionCounter = 0
DisplayQuestionCounterOffset = 0
SectionCounter = 0


CurrentSeconds = 0
CurrentMinutes = 0

'Read the current computer time, the clock time
StartTimer = Timer
StartSectionTimer = StartTimer


'display the section counter, the question counter and the starting time.
If (QuestionArray(SectionCounter) = 0) Then
     Text1.Text = ""
Else
     Text1.Text = QuestionCounter
End If
```

```
Text3.Text = SectionCounter + 1
Text4.Text = "00:00"


'Clock Event   - the clock is programmed to create events much more
'often than the minimal time unit programmable by the user
'In this case, the clock event is created every 10 ms, while the minimal
'time unit programmable by the user is 1 minute.


'display time in section, first collect the current time from the clock
 EndTime = Timer

'total time from the beginning of the group of sections, until timer reset
TotalTime = EndTime - StartTimer

'total time from the beginning of the current section
TotalSectionTime = EndTime - StartSectionTimer


'If the specified time is 0, skip the section; if it is the last section,
'stop the running mode.
'otherwise compute what question from the current section should be
'displayed.

If TimeArray(SectionCounter) <= 0 Then
        SectionCounter = SectionCounter + 1
        StartSectionTime = EndTime ' set to current time
        If SectionCounter >= MAX_SECTIONS Then
                Beep
                MsgBox ("End of Sequence")
                Unload Form1
        End If
        Exit Sub
    Else
        'increase section time
        QuestionCounter = TimeTransform(TimeArray(SectionCounter),
QuestionArray(SectionCounter), TotalSectionTime)
    End If


'if the number of questions programmed for the current section is 0, then
'the QuestionCounter is kept to 0 for the section and the TotalSectionTime
'is compared
'to the programmed time for the section. The 60 multiplier is used to
'transform the time from minutes to seconds, to match the TotalSectionTime
'units. When the time
'expires, the timer will move to the next section.
    If (QuestionArray(SectionCounter) = 0) Then
        QuestionCounter = 0
        If TotalSectionTime > 60 * TimeArray(SectionCounter) Then
            SectionCounter = SectionCounter + 1
            StartSectionTime = EndTime  ' set to current time
            If SectionCounter >= MAX_SECTIONS Then
```

```
                Beep
                MsgBox ("End of Sequence")
                Unload Form1
            End If
            Exit Sub
        End If
    End If

'if the question number for this section is higher than the number of
'questions requested for the section, it is time for a section increase.
'the timer moves to the next section. The section start timer is set to
'the current time.  The timer displeyed and the question displayed are
'reset, if so programmed.
' the  DisplayQuestionCounterOffset keeps track of the questions in
'previous sections, that need to be added to the questions in the current
'section, before a question number is displayed. The QuestionCounter, which
'stores the number of the question to be displayed from the current section
'is set back to 1.

If QuestionCounter > QuestionArray(SectionCounter) Then

   SectionCounter = SectionCounter + 1
   StartSectionTimer = EndTime ' set to current time
   If SectionCounter >= MAX_SECTIONS Then
      Beep
      MsgBox ("End of Sequence")
      Unload Form1
      Exit Sub
   End If

   If TimerReset(SectionCounter) = 1 Then
      StartTimer = StartSectionTimer
   End If

   If QuestionReset(SectionCounter) = 1 Then
      DisplayQuestionCounterOffset = 0
   Else
      DisplayQuestionCounterOffset = QuestionArray(SectionCounter - 1) + _
            DisplayQuestionCounterOffset
   End If

   QuestionCounter = 1


End If

'data is ready for display. DisplayQuestionCounter is the question number
'displayed on the screen.

DisplayQuestionCounter = DisplayQuestionCounterOffset + QuestionCounter


'display the question number, unless the current section is a pause
'section, with no questions programmed for it.
If (QuestionArray(SectionCounter) = 0) Then
```

```
    Text1.Text = ""
Else
    Text1.Text = DisplayQuestionCounter
End If
'Total time keeps track of the time since the last Time Reset. The number
'is converted into seconds and minutes and displayed. The prototype does
'not keep track of groups of sections longer than an hour. The section
'counter is displayed.

CurrentSeconds = Int(TotalTime) Mod 60
CurrentMinutes = Int(Int(TotalTime) / 60)

If (CurrentSeconds < 10) Then
    strCurrentSeconds = "0" + CStr(CurrentSeconds)
Else
    strCurrentSeconds = CStr(CurrentSeconds)
End If
If (CurrentMinutes < 10) Then
    strCurrentMinutes = "0" + CStr(CurrentMinutes)
Else
    strCurrentMinutes = CStr(CurrentMinutes)
End If
Text4.Text = strCurrentMinutes + ":" + strCurrentSeconds
Text3.Text = SectionCounter + 1

'The TimeTransform function is in this case linear.
'The number of Ticks is the number of questions in this case.


Function TimeTransform(iTime As Integer, iNumberOfTicks As Integer,
TotalSectionTime As Variant) As Integer
    Dim LinearTime As Double

    If iNumberOfTicks > 0 Then
        LinearTime = Int(iTime * 60 / iNumberOfTicks)
    Else
        LinearTime = iTime
    End If

    TimeTransform = Int(TotalSectionTime / LinearTime) + 1

End Function
```

Referring to ***Figure 20***, a portable electronic timer of the type that may employ the features of this invention is shown in pictorial form. Its embodiment is similar to a wristwatch.

The electronic timer 201 comprises a liquid crystal display 202, a button keyboard pad which comprises a setting button 203, an exam setting button 204, an Up/Down button 205 and a start/stop button 206

The operation of the device is as follows:

The device is always on. The display will show:

Sec 1 PERS1

Q: 0 R

T: 0 R

The user will select first which memory group is to be programmed by using the exam setting button. Pressing the button will circle SAT/PSAT/PERS1/PERS2 settings. The setting will be displayed on the screen.

The user will press the setting button. The display will blink the Sec setting. The user use the Up/Down button to change the number displayed from 0 to the desired number of the section to be programmed.

The user will press the setting button. The display will blink the T setting. The user use the Up/Down button to change the number displayed from 0 to the desired number of minutes. Setting the time in minutes is particular to this application. Different applications may use different time measurements. Then the user will press again the setting button. The display will blink the Q setting. The user use the Up/Down button to change the number displayed from 0 to the desired number of questions. Then the user will press again the setting button. The display will blink the R setting next to T, The user will use the Up/Down button to change the setting from R (Reset) to blank (non-Reset) for the time counter. The Up/Down button will work as a toggle in this case. Then the user will press again the setting button. The display will blink the R setting next to Q;

the user will use the Up/Down button to change the setting from R (Reset) to blank (non-Reset) for the question counter. The Up/Down button will work as a toggle in this case.

The programming can continue with the following section. After all the sections have been programmed, the device is ready to run. The timer starts upon pressing the Start/Stop button, changing the mode of operation to the running mode. Upon another press of the Start/Stop button, the mode changes again to the setting mode.

This embodiment does not have the Timer Mode and the Alarm Mode.

While the invention has been described in connection with a preferred embodiment, it is not intended to limit the scope of the invention to the particular form set forth, but on the contrary, it is intended to cover such alternatives, modifications, and equivalents as may be included within the spirit and scope of the invention as defined by the appended claims.